5.2 Analytical Support of Aerial Flyovers Conducted by Another Agency

Technology Need

In order to measure environmental changes and signatures of nuclear weapons production over time, a multi-temporal approach is necessary. In this application, it is critical that different types of data be spatially registered, calibrated, and compiled into a common format in order to make accurate observations. A computerized digital image processing system will be used for the analysis and visualization of data acquired in this project and from existing archives. The system includes functions for image processing, geographic data processing, and relational database operations. New algorithms and processing models for radiometric calibration and automatic signature recognition will be developed and implemented on the system.

Technology Description

The purpose of this project is to identify spectral and temporal signatures that can be used for environmental characterization at DOE sites and to develop analytical techniques for identifying environmental indicators of special nuclear materials production.

Aerial Multispectral data has been acquired over select targets at the Savannah River Site yearly as part of classified and standard DOE projects. The focus of these collection efforts are short and long term signatures that can be exploited for environmental and counter-proliferation purposes. Identification of signatures associated with the production and reprocessing of nuclear materials is an important part of that focus.

It is very difficult to identify clandestine nuclear weapons production facilities directly, but there may be environmental indicators that would suggest their existence. Those indicators are related to the environmental effects of hazardous waste disposal and/or thermal discharge. Coincidentally, these same factors are a major concern for environmental restoration at DOE facilities.

The "spectral signature" of features is determined by the unique reflectance and emittance patterns that can be discriminated in each of the channels. Multispectral imagery must be calibrated before quantitative radiometric signatures can be correlated. There exists a large archive of uncalibrated historical data that could be invaluable for monitoring temporal changes if a technique could be developed for absolute or relative calibration.

In addition to radiometric calibration, this effort will focus on the detection and characterization of buried wastes and underground storage tanks. The detection of soil disturbances resulting from burying objects with visible, reflective infrared and thermal infrared sensors depends on many surface and subsurface characteristics. These factors interact and change in relative importance, making the net effect difficult to predict. In addition, the potential range of target versus background conditions makes it extremely difficult to predict discrimination accuracy or provide a generalized solution to the problem.

The F and H areas of the Savannah River Site and associated burial grounds will be the primary focus area for this study.

Benefits

Any new processing technique that can take advantage of remotely sensed data can reduce costs and minimize the time required to complete ground-based environmental characterization surveys. In this specific project, the DOE can take advantage of the data that was collected over many years and by another agency and direct their support to the development of exploitation algorithms.

Collaboration/Technology Transfer

The results of this investigation will be briefed to DOE and to the other agencies cooperating in this activity. If successful, certain portions of the results may be considered sensitive and not made available for wide distribution. All algorithms and processing models developed in this activity will be made available to DOE and participating agencies within security guidelines determined by DOE and other agencies.

Accomplishments

The work for this project is in its preliminary stages and consists mostly of database identification and "proof-of-concept" demonstrations. The work so far includes:

- Identification of archived image data sets useful for this project.
- Processing and archiving of these data sets for easy retrieval.
- Collection of Geographical Information System (GIS) coverages for a regional coordinate system and identification of features within the imagery.
- Calibration of current image data using ground targets of measured (known) reflectance (via calibrated reflectance panels or "in-scene" targets).
- Calibration of archived image data by comparison with current calibrated data ("scene-to-scene" calibration, see Figure 5.2-1).

- Spatially register 1985 and 1995 image data sets (1985 was the earliest use of the Daedalus 1268 MSS scanner). Use of image collected before data sets will require comparison of data from different scanners which have different characteristics and collect light in different wavebands.
- Demonstration of the capabilities of registered and calibrated multi-temporal image data sets
- Generation of graphic products illustrating methodologies and capabilities of the techniques developed.

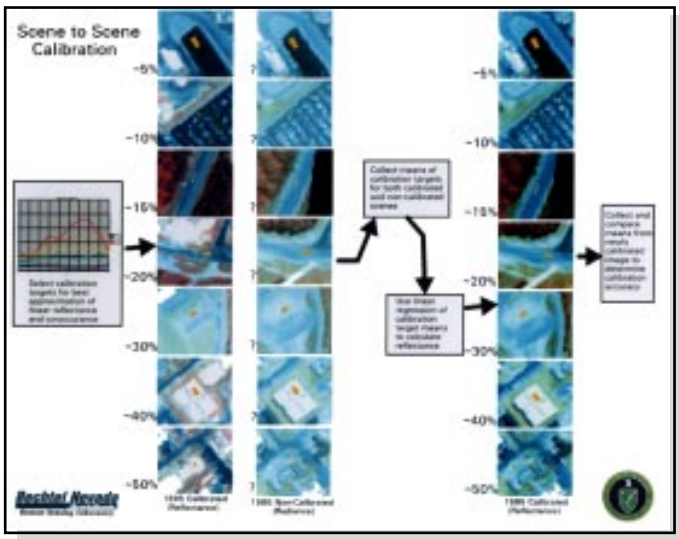

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Figure 5.2-1 Scene to scene radiometric normalization for coherent change detection.

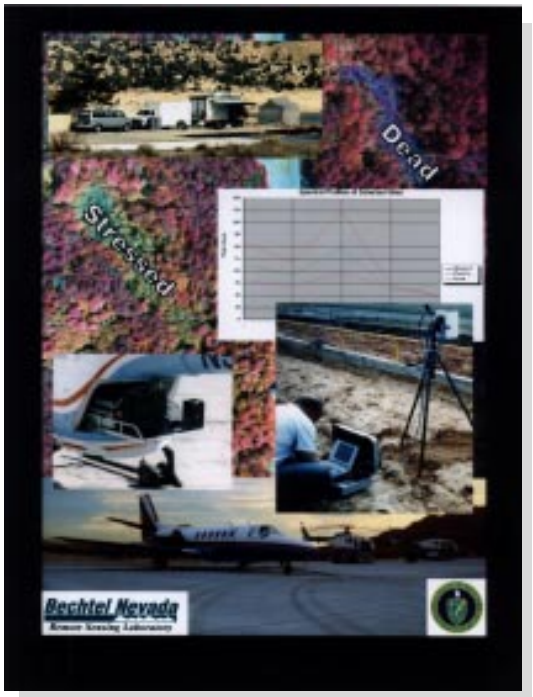

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Figure 5.2-2 Simultaneous collection of airborne, ground data, and atmospherics for characterizing target phenomenolgy.

TTP Information

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Bibliography of Key Publications

None available at this time.